Upgrade of Heating System for Energy Conservation at DSS 62, Cebreros, Spain

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This report presents a description of the modification performed as part of the energy conservation program at the Cebreros, Spain, Deep Space Station (DSS 62) and the results obtained. The article was excerpted from the final engineering report on this project by E. H. Thom.

I. Summary

This report presents a description of the modification performed as part of the energy conservation program at the Cebreros, Spain, Deep Space Station (DSS 62) and the results obtained. The modification is based on the elimination of the air-conditioning boiler and the heating of the operations building by the waste heat from the power generator engines. Consequently, by transporting dissipated heat from the powerplant to the operations building, this modification will represent an energy savings of 70,000 liters per year in boiler fuel and a cost savings (at current prices) of $12,000 per year.

II. System Comparison

The following is a comparison of the major heat producing components comprising the former and the new heating systems.

A. Boiler (Former System)

The boiler is located in the operations building and was previously used to provide hot water for heating and ordinary purposes. It is an automatic unit capable of maintaining a constant temperature of 65–85°C and a flow of 220 liters per minute up to a maximum 140,000 kcal/hour. The annual fuel consumption of this unit is 70,000 liters under normal weather conditions.

B. Generators (New System)

The station powerplant contains four diesel generators capable of producing a total of 1,850 kW, divided as follows:

Three 500-kW units

One 350-kW unit

Normal station operations require about 400 kW with a normal generator configuration of two generators on the line. Generator engine cooling is accomplished by radiators with electric fans. In this arrangement, the cooling water reaches a temperature of 85°C — heat which is wasted into the atmosphere.

The heat dissipated in the radiator is proportional to the load. Figure 1 shows the upper and lower load limits over a 24-hour period, as well as the heat dissipated at each limit. As indicated, the heat wasted at the lower limit (190,000 kcal/hour) is higher than the maximum output of the referenced boiler, thus providing a clear advantage over the former system.

III. Implementation

A. Technical Background

The possibility of bringing the water from the engines directly to the operations building was rejected primarily for the following reasons:

(1) Danger of failures which would affect the engines.

(2) Incompatibility between circuit flows.

(3) Pressure drops or increases which would jeopardize engine operation.

(4) Static pressure increases, caused by variations in building heights, which would affect the engine circuit.

These and other reasons recommended the use of a heat exchanger in order to maintain the independence of both circuits while transferring heat from one to the other. Heat exchanger capacity permits a maximum heat transfer of 225,000 kcal/hour from the primary to the secondary circuit when the temperatures of both circuits are:

Primary	inlet	85°C
	outlet	65°C
Secondary	inlet	60°C
	outlet	75°C

B. Configuration and Materials

Since the amount of heat to be dissipated in the primary circuit is always greater than the requirements of the second circuit, some of this heat must continue to be dissipated in the radiator. To facilitate this function, a three-way motorized valve has been added. This valve divides the water flow to permit direct flow to the engine and indirect flow via the radiator. In this way, the water entering the engine can be maintained at 60°C.

The temperature of the return water is kept at 60°C to ensure that the thermostatic bypass of the engine permits sufficient flow in the outside circuit and thereby maintains adequate heat exchanger performance. Each engine has been provided with a proportional thermostat connected via a selector switch to the heating engine. This controls the motorized valve which maintains the inlet temperature at the pre-established 60°C.

The valve drive motor contains a spring that returns the valve to the radiator position. This setting allows the entire flow to circulate through the radiator. The purpose of the device is to eliminate the possibility of an engine shutdown due to overheating indirectly caused by an electrical failure in the valve control.

C. Costs

It should be noted that the implementation has been performed employing on-hand or surplus materials whenever possible. Furthermore, no additional costs for project preparation or implementation are applicable since these tasks were undertaken entirely by station personnel. In summation, this item includes only the costs of purchased materials as follows:

Heat exchanger	$ 4,330
Pumps	1,025
Three-way valve	687
Insulation	2,760
Piping, manual valves, supports, screws, etc.	5,629
Total	$14,431

IV. Conclusions

System operation has been completely satisfactory with an available water flow of 250 liters/minute and a temperature on arrival at the operations building of 71°C. Moreover, a potential increase of 60,000 kcal/hour has been obtained over the previous system.

Despite the fact that no extremely cold days have been experienced since its implementation (minimum temperature 10°C), the new system promises to yield excellent performance due to its large heat reserve.

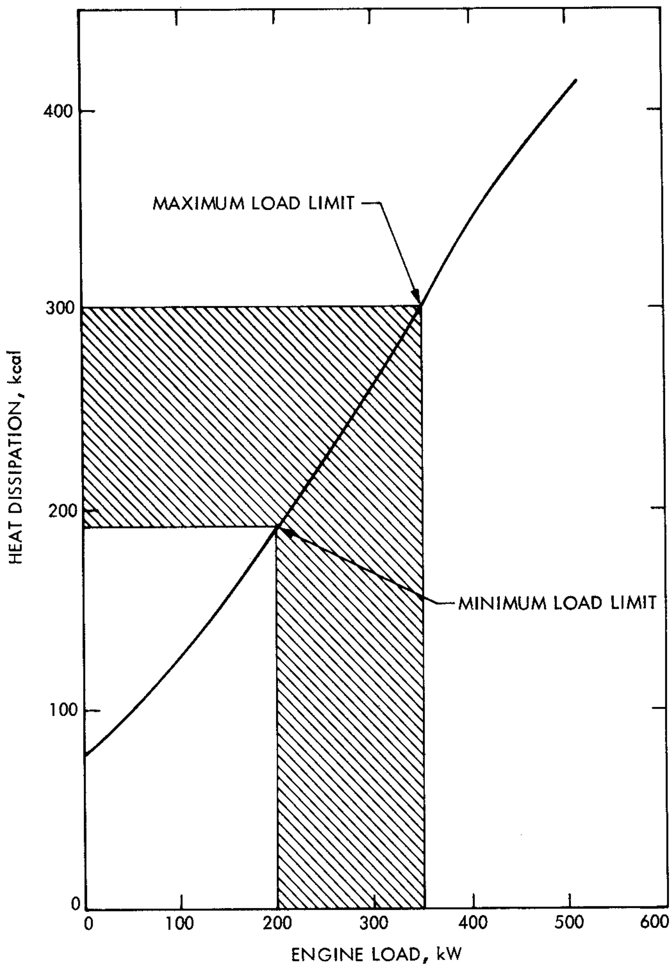

Fig. 1. Engine heat dissipation vs generator load